Mars Cube One (MarCO)

Jet Propulsion Laboratory
California Institute of Technology

Sami Asmar

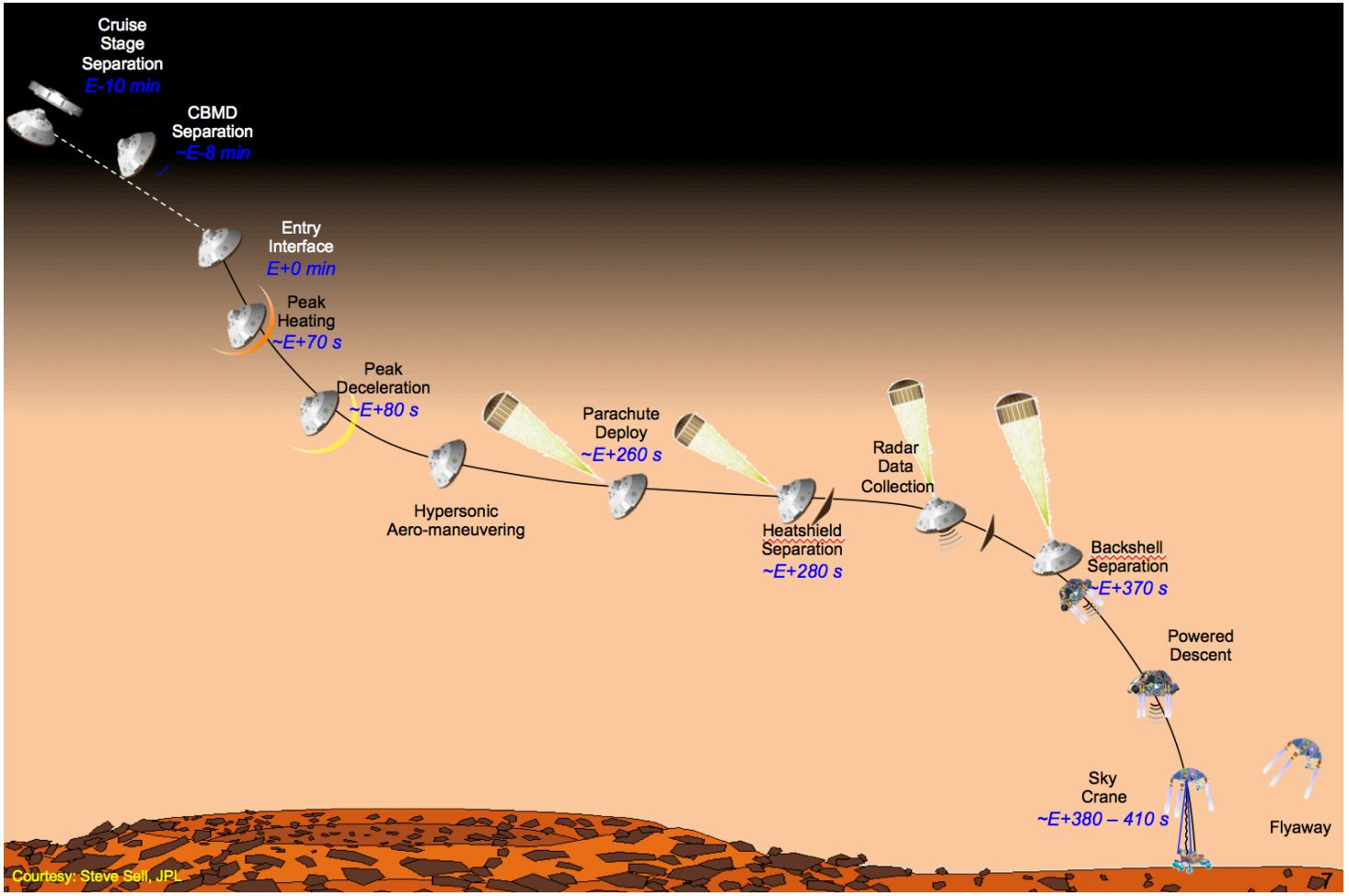
Sardinia Seminar

Mars Cube One (MarCO)

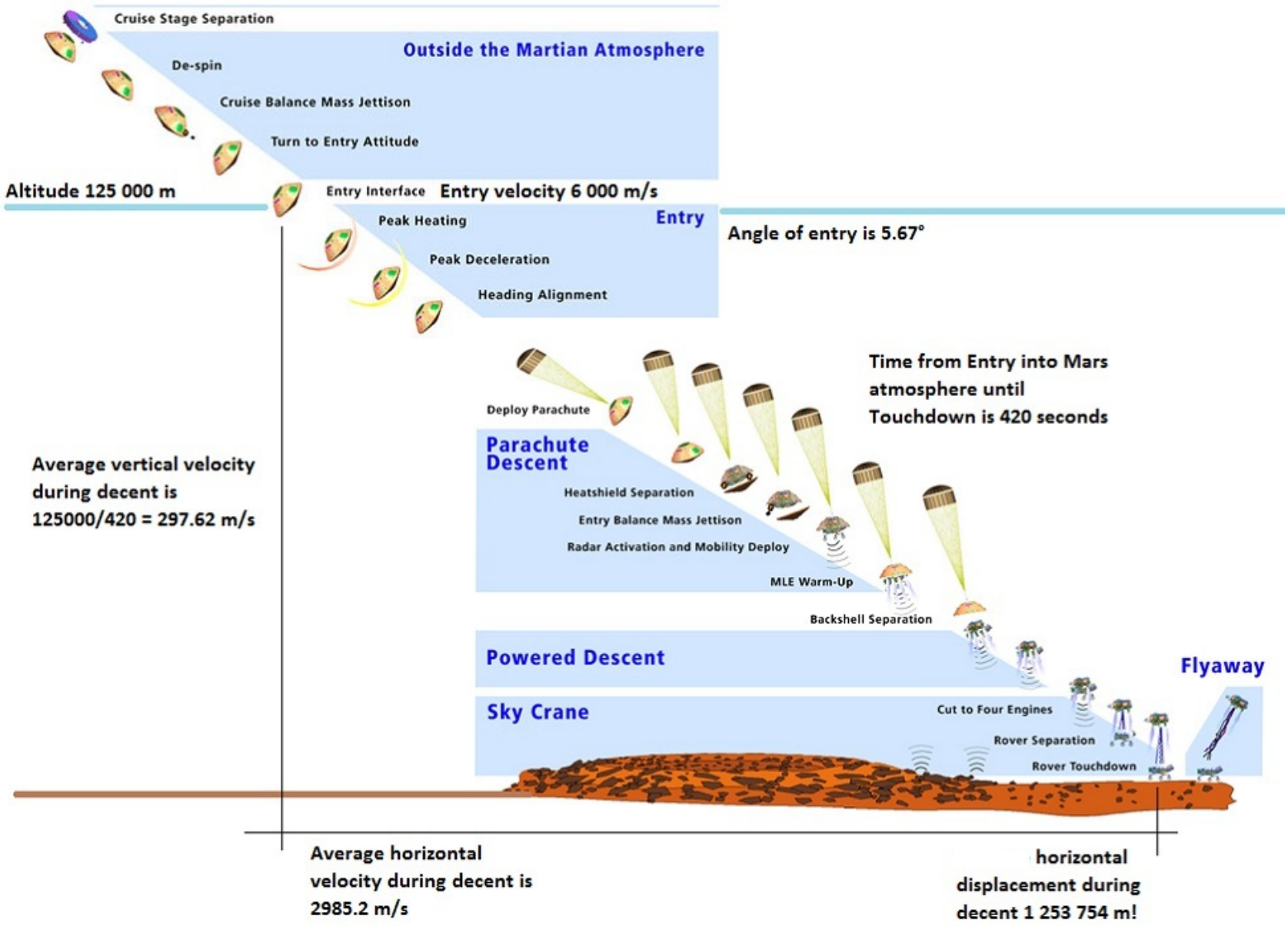
Shifting the Paradigm in Relay Deep Space Operations

EDL Minutes of Terror

- Planetary landers' highest risk is during Entry, Descent, and Landing phase
- Communications is vital but very difficult



EDL Complexity



Communications Methods - Relay

- An orbiter overhead receives UHF signal from lander
- Relays telemetry to DSN

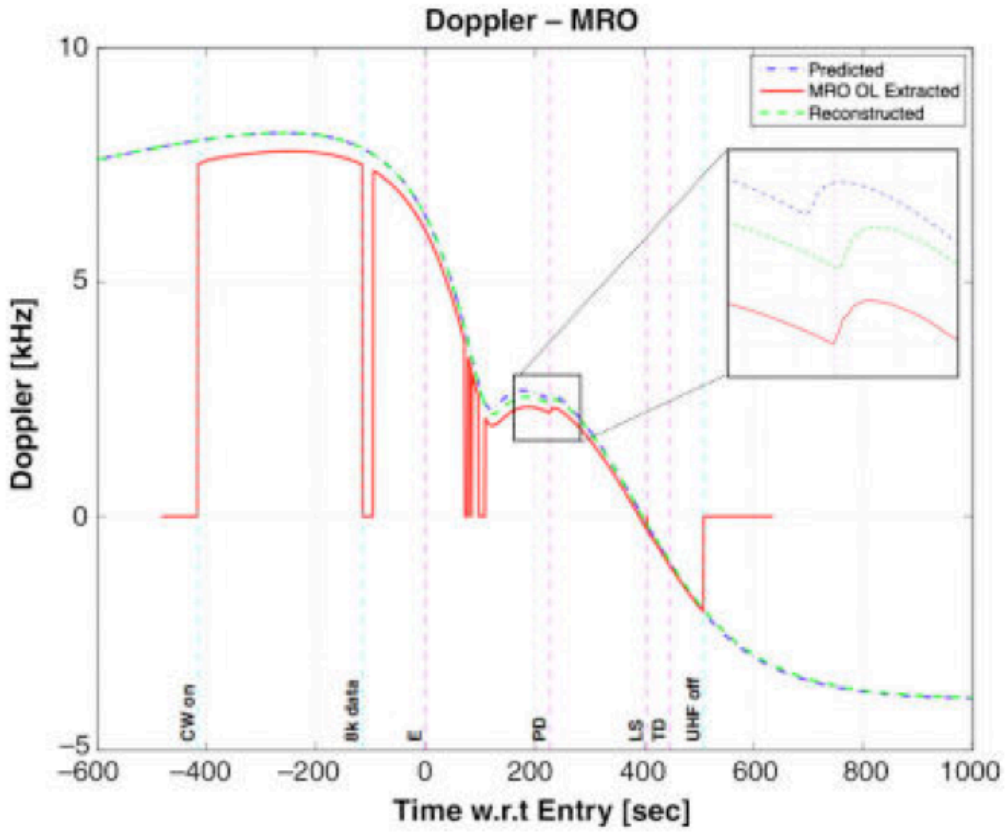
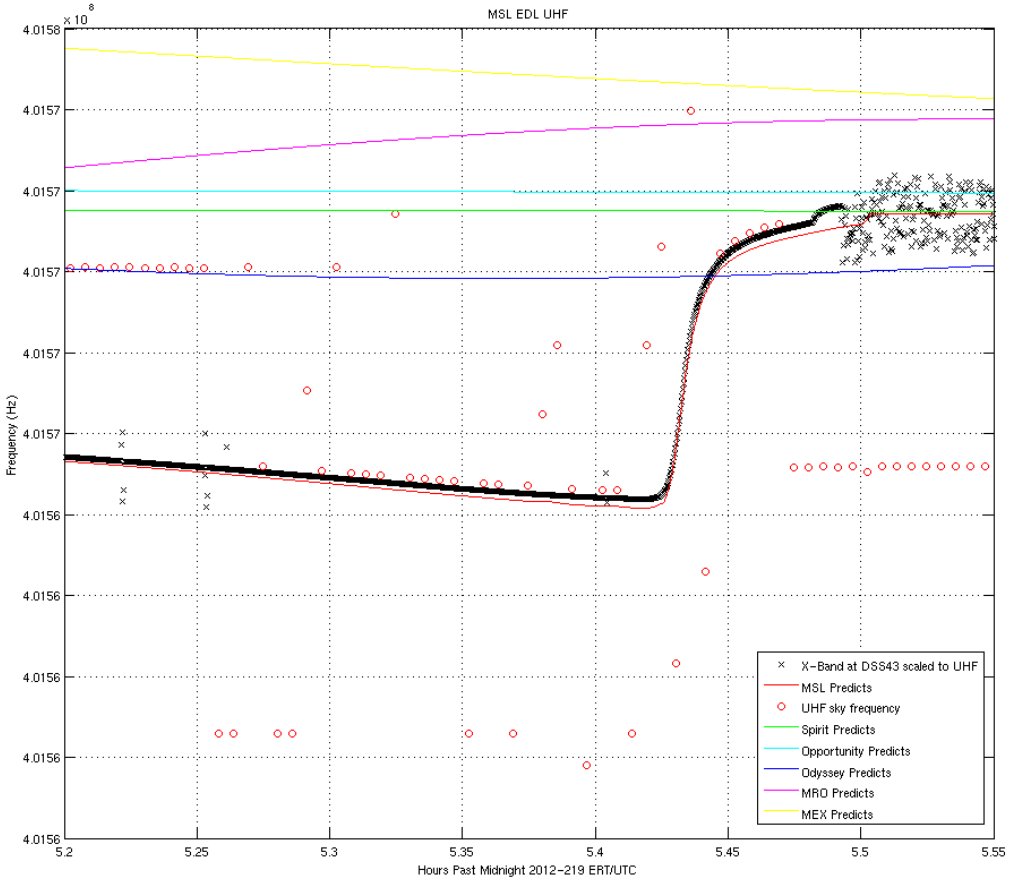


Figure 2. The Doppler profile of the EDL sequence of the Phoenix mission as captured and relayed through the MRO spacecraft in 2008.

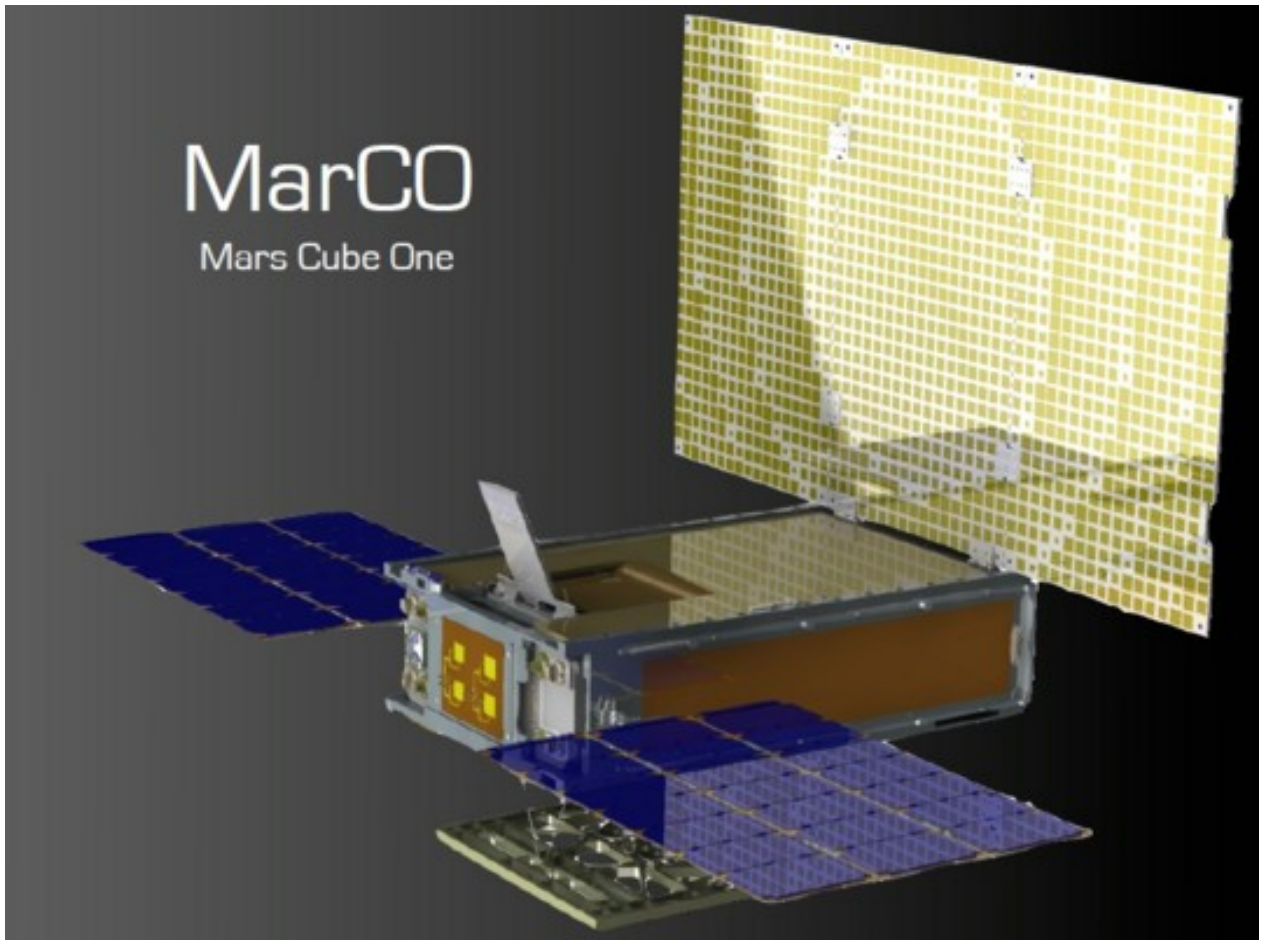
Communications Methods – Direct to Earth

- In the absence of sufficient link budget for telemetry, the Doppler profile received at Earth reveals very important information
- Curiosity UHF Doppler profile received at Parkes Radio Telescope in 2012



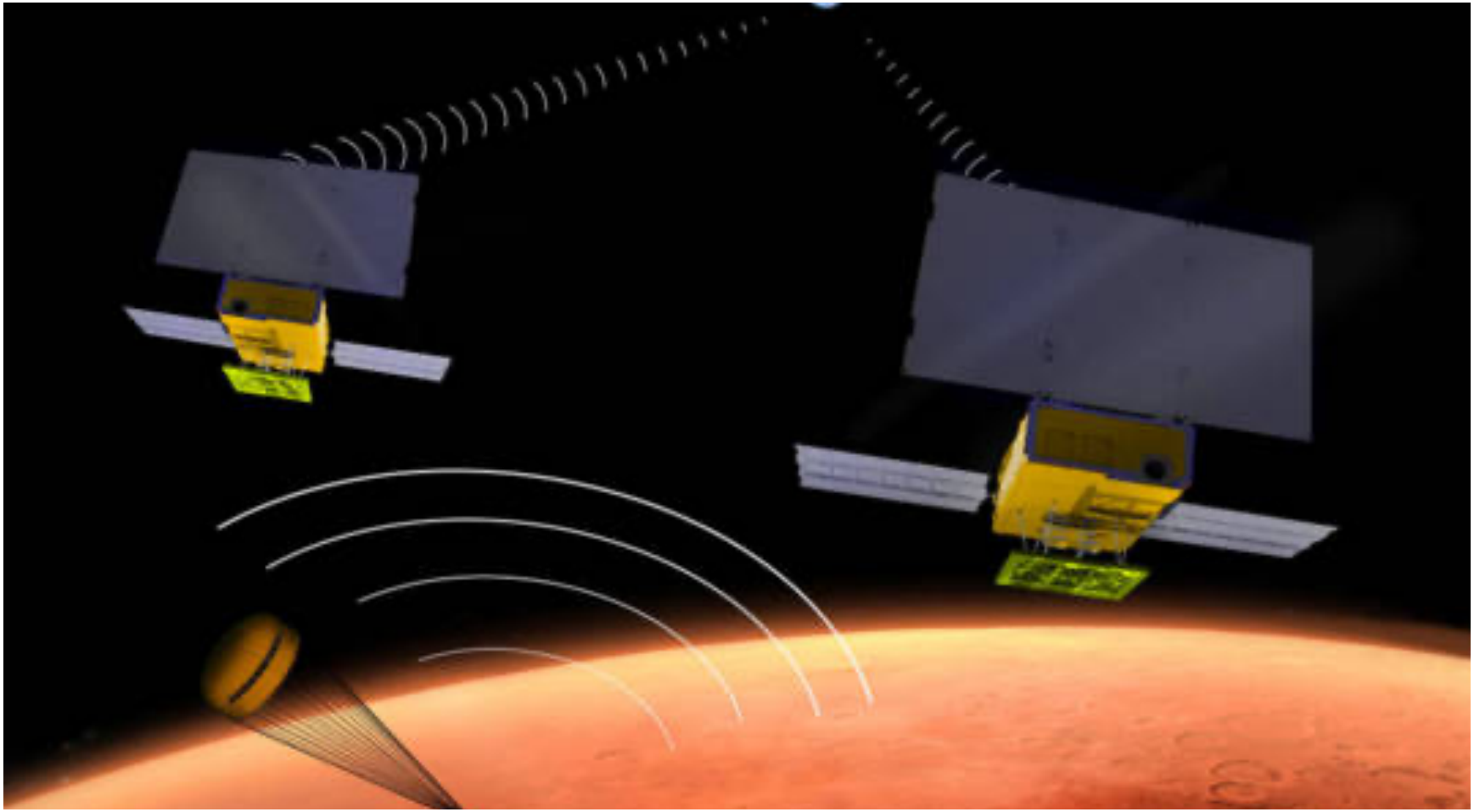
Communications Methods – Introducing MarCO

- CubeSats have not flown in deep space yet
- Fly a CubeSat with the mission to watch EDL event and relay data to DSN



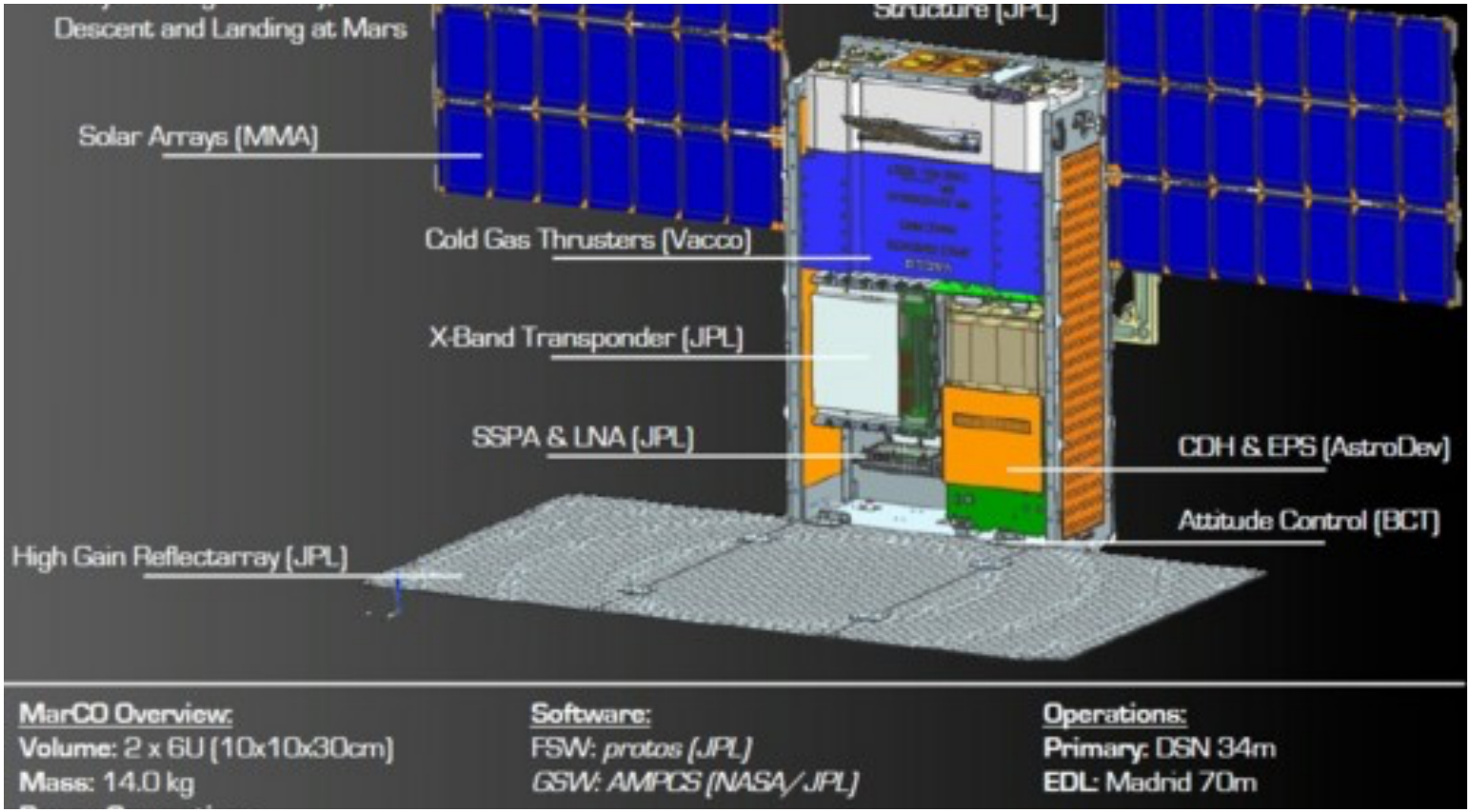
MarCO Special Features

- Enabled via advances in CubeSats and radio communications systems
- Needed to develop antennas that can handle UHF and X-band data rates
- Iris radio (second generation)

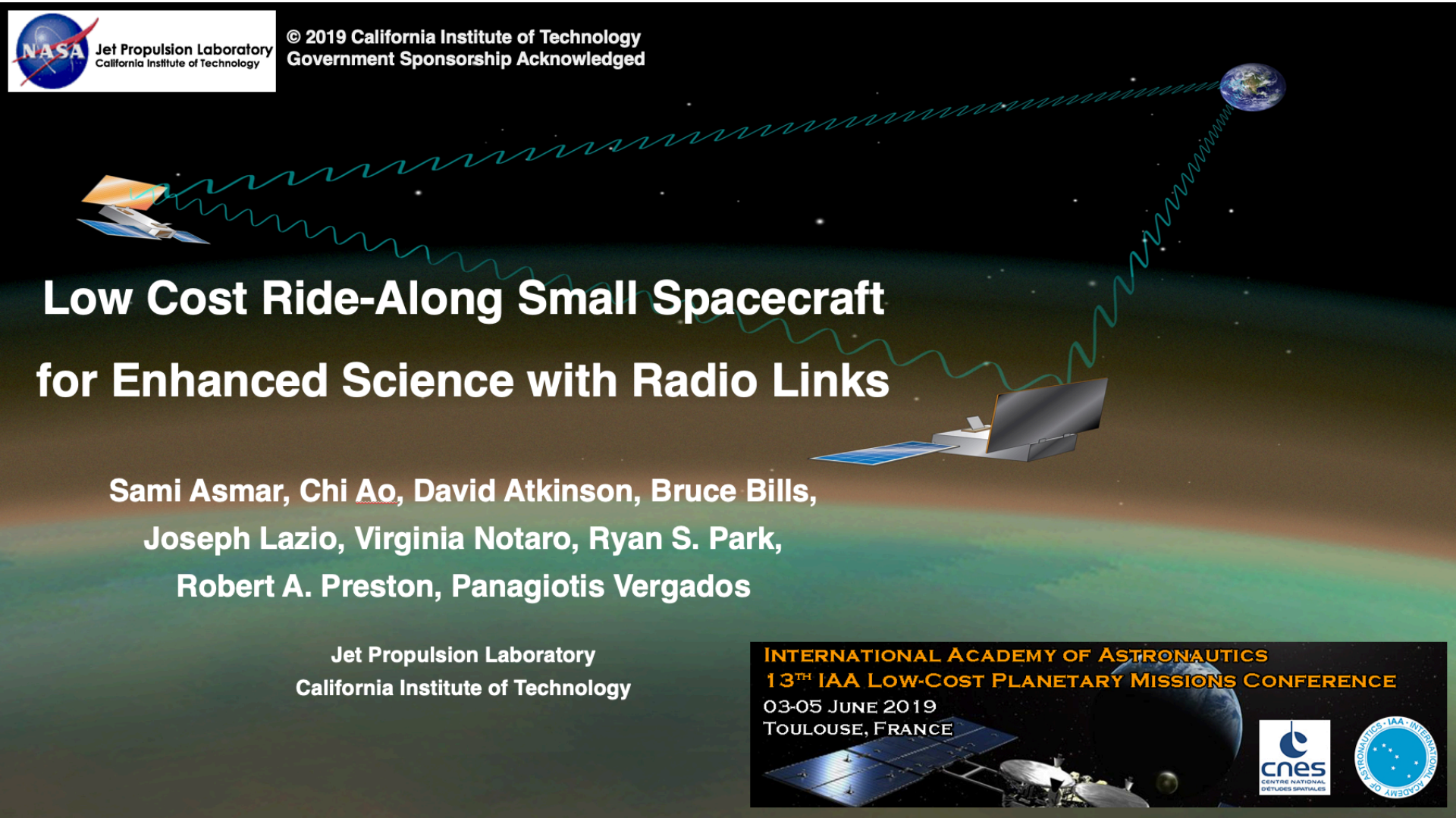


Stand Alone Mission

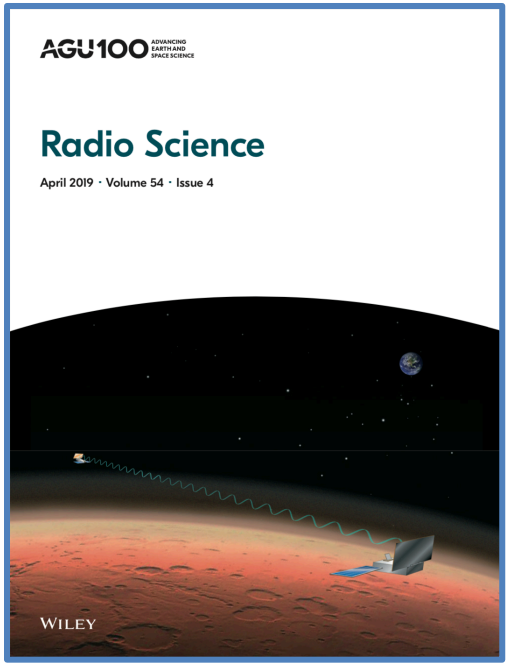
- MarCO carried on the same launch rocket as InSight but released around Earth and travel independently to Mars
- Carry all spacecraft subsystems for maneuvers and other functions



Future Applications in Planetary Science



Conclusion



- Innovative concept of ***carry your own relay***
- Reduced the mission risk significantly at critical phases **at low cost**
- Can become common practice after the initial demonstration of technology
- Future concepts being examined for applications of MarCO-like planetary missions is Radio Science experiments
  - Spacecraft-to-spacecraft links enabled by two or multiple CubeSats around a planet
  - Utilize radio occultations of the atmosphere for profiling the ionosphere & neutral atmosphere
  - Surface scattering from the planet to characterize its material and electrical properties
  - The concept of crosslink radio occultations has been demonstrated between the Odyssey and MRO spacecraft and simulations show significant advantage in global coverage and SNR with two MarCOs around Mars
- Other scientific breakthroughs expected to be enabled with this method.